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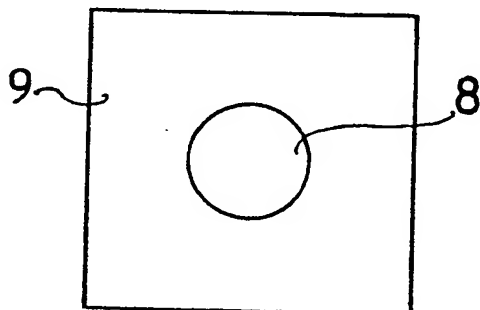
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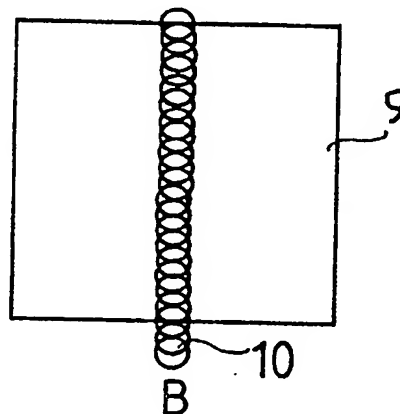
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification<sup>4</sup> : <b>B41F 33/00, G01J 3/50</b> <b>G01N 21/86</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 87/ 06190</b> (43) International Publication Date: 22 October 1987 (22.10.87)</p>
<p>(21) International Application Number: PCT/FI87/00049 (22) International Filing Date: 14 April 1987 (14.04.87) (31) Priority Application Number: 861578 (32) Priority Date: 14 April 1986 (14.04.86) (33) Priority Country: FI (71) Applicant (for all designated States except US): VALTION TEKILLINEN TUTKIMUSKESKUS [FI/FI]; Vuorimiehentie 5, SF-02150 Espoo (FI). (72) Inventor; and (75) Inventor/Applicant (for US only) : SIMOMAA, Kimmo [FI/FI]; Metallimiehenkuja 8, SF-02150 Espoo (FI). (74) Agent: PAPULA REIN LAHTELA OY; Kansakoulukatu 5 A, SF-00100 Helsinki (FI).</p>		<p>(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK, FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), NO, SE (European patent), US.  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Finnish).</i></p>

(54) Title: METHOD FOR CONTROLLING PRINT QUALITY



A



(57) Abstract

Method for controlling printing quality in a web printing press by measuring at least the darkness of the colour surface in the printed product by employing a web sensor, wherein on a moving paper web there is arranged a test spot (9) and/or test patterns in the middle and/or aside the saleable printing, and wherein the operation of the web sensor is synchronized with the said test spots while they move along the paper web past the sensor, and wherein a light beam is focused onto the paper web from the light source of the web sensor, and the reflections of the said light beam from the test spot are measured by employing a light detector. The invention is characterized by the fact that the spot of light (10) formed on the paper web by the light beam is limited in comparison with a normally used spot of light (8) at least in the motional direction of the paper web so that it remains roughly between 1-2 mm. By aid of the limited spot of light of the same web sensor, there is measured the reciprocal registering of the different colours. Moreover, the same test spots and/or patterns are used while measuring the darkness of the colour surface and the registration of different colours.

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## METHOD FOR CONTROLLING PRINT QUALITY

The present invention relates to a method for controlling print quality in a web printing press by measuring at least the darkness of the colour surface of the printed product by aid of a web sensor, wherein on the moving paper web there is arranged a test spot and/or test patterns in the middle and/or aside the saleable printing, and the operation of the web sensor is synchronized with the said test spots while they move, along with the paper web, past the sensor, so that from the light source of the said web sensor there is focused a light beam onto the paper web, and the scatterings of the said light beam from the test surface are measured by employing a light detector.

In the art of printing, it is necessary to measure the darkness of the product surface, as well as the reciprocal registration of the respective colours in order to achieve a product which has a high quality from the commercial point of view. Web densitometers have long been used for measuring colour darkness, as well as register measurement devices for measuring the reciprocal registration of different colours. The structure of web densitometers is explained for instance in the article "Design and construction of multichannel on-press densitometers for print quality monitoring" by Kimmo Simomaa and Tapio Lehtonen, published in Graphic Arts in Finland, 1982.

The standardization of print quality, for instance by employing closed-loop control, usually requires that the test spots indicating the relative shifting of the partial images printed using separate inks, i.e. cyan, magenta, yellow and black, are printed in the middle of the saleable printing, and that the web sensor is synchronized with the said test spots while they move past the sensor along with the paper web. A typical feature of the prior art web densitometers has been that they measure the optical reflection density of the test

spot within an area of roughly 9 square millimeters, which means that the light beam focused thereon has a diameter of roughly 3-4 mm. This practice originates from the manual desktop densitometers, where the measuring can be arranged to take place exactly at the desired spot in the printing. In the case of a web densitometer, the determination of the measuring spot is more problematic: the 3-4 mm light spot must fall on the printed test surface, such as the test spot, the length whereof - in the moving direction of the paper web - is in practice 6 mm at the most. In order to make a 3-4 mm spotlight to fall exactly on the test area, the measuring operation must be synchronized at the minimum accuracy of  $\pm 1,5$  mm. In reality the synchronization accuracy must be roughly  $\pm 0.5$  mm, if absolute certainty is required that the light detector of the web sensor does not see anything outside the 6 mm test area. Observation of the vicinity is a drawback, if the test area represents black printing and the vicinity is a light printing sheet or the like. Except that the 3-4 mm test area is a general practice, it is also indirectly recommended by the DIN standard 16536/16527: the large size of the test spot helps to filter the variation caused by irregularities in the paper and the printing.

By employing the method of the present invention, there is achieved a distinctive improvement compared to the measurement carried out by aid of the above described web densitometer. In order to realize this, the method of the invention is characterized by the features enlisted in the appended patent claims.

As for the advantages of the invention, the following is pointed out. The diameter, or the largest dimension of the light spot formed on the paper web by the light beam in the motional direction of the web, could be for instance 1-2 mm, in which case the synchronizing of the measurement with the 6 mm test area becomes easier, or, with careful synchronizing, a test pattern of even 4 mm can be used, which helps in selling the web sensors for customers in the printing trade. When employing web

densitometers, the diminishing of the test area is easily compensated by repeating the measurement on successive sheets or equivalent, and by calculating the measuring result proper as an average of the obtained partial measurements. In a microprocessor-based arrangement, there can also be carried out several separate measurements within the range of the same test area, if the edge readings are rejected. If the measuring area is reduced for instance to 1/10 of the original, the measurement is carried out on 10 successive sheets, or on 3 sheets, if for instance 3-4 measurements are performed on each sheet. Thus the good control interval, i.e. 20 sheets, can be maintained in the automated density control.

A small-size light spot can be realized by aid of a conventional lens arrangement, and the employed light source can be either a semiconductor lamp, a filament lamp or a Xenon flash tube, which are all known in the prior art. A new method for the projection of light onto paper is the use of cylindrical lenses. By aid of a cylinder lens which is installed in the transversal direction of the paper web, there can easily be realized the above mentioned short, small-sized light spot, which in this case means the duration of the illumination in the driving direction. In addition to this, the cylinder lens has the advantage that by employing one single light source, there can also be illuminated for instance the adjacent test area or test spot, which reduces the amount of required light sources. In the transversal direction of the web the light spot is limited for instance by using mechanical apertures.

The reduction of the light spot size used in the web densitometer measurement according to the invention makes it possible also to measure the registration of the colours with the same sensor. The data measured by the web sensor are processed for example simultaneously in two separate data processing units: there is provided specific equipment for measuring the density and register respectively. The measuring of the register is carried

out according to generally known principles.

The employed test pattern in the register measurement can naturally be of any possible type. The darkness of the colour surface could in fact be measured on the basis of the register test pattern, if the sensor of the present invention were utilized. The usefulness of the measuring arrangement here described works both ways: the accurate definition of the darkness on the basis of the density computation would make the definition of the edge position, i.e. the registration, more reliable. The greatest advantage gained by the twofold darkness and registration sensor is, however, the fact that the manufacturing costs are essentially reduced, and moreover the instalment of one common measuring sensor clamping bar in the printing press will be simple.

In the following the invention is explained in more detail with reference to the appended drawings, wherein

figure 1 is an illustration of a web sensor applying the method of the present invention;

figure 2 is an illustration of the same web sensor seen from above;

figure 3 illustrates the comparison between a web sensor (A) employing a large light spot and measuring the darkness of the colour surface, and the web sensor (B) operated according to the method of the present invention; and

figure 4 is an illustration of a measuring system according to the method of the present invention.

The web sensor of figure 1 comprises the light source 1, the optics connected thereto, which include for instance the condenser lens 2 and the focusing lens 3. On the paper web 4, or on some other respective material, there is arranged a test spot and/or test patterns 5 in the middle and/or aside the saleable printing. The operation of the web sensor is synchronized with the said test spots while they move past the sensor along with the paper web. The motional direction of the paper web 4 is upwards from the level of figure 1. The light detector or

detectors 6 are arranged at an angle with respect to the light beam directed towards the paper web, most advantageously so that the diffusely reflected, i.e. scattered light from the test pattern 5 can thereby be observed. In this case the light beam of the light source 1 is directed against the web surface at an angle of 45°, and the detector is arranged at an angle of 90° with respect to the web surface.

In this preferred embodiment, the focusing lens 3 is like in figures 1 and 2. The cylinder lens 3 is placed transversally with respect to the moving direction of the web, and the width of the light spot 7 is preferably 1-2 mm. In the transversal direction of the web, the light spots are limited for instance by aid of the mechanical aperture 3a. By means of this arrangement, for example 5 adjacent test spots can be illuminated (detectors 61, 62, 63, 64 and 65).

In figure 3A it is seen that in the prior art sensors for measuring the darkness of the colour surface, a large light spot 8 with respect to the test area 9 is employed, whereas the method of the present invention employs a small light spot 10.

The use of the small-size light spot enables the combination of two completely different measurements, i.e. the measurement of the darkness of the colour surface and the registration of different colours. Test areas are needed in both measurements, but they are different in nature, wherefore in conventional measurements both have their own respective marks, which consequently take up a lot of the printing space on the web. The registration measuring marks are relatively small, and usually there is only needed a right-angled triangle in order to measure the transversal and longitudinal registration of different colours. Thus the number of marks in four-colour printing is four. The location of the edges is the only feature of the marks to be measured. Normally these are observed by aid of a light source strongly focused by optics and by aid of a detector.

By means of the method of the present invention,

both of these aforementioned measuring procedures can be combined into one. One such measuring arrangement is illustrated in figure 4.

The said measuring arrangement comprises the web sensor 11, the tachometer 12, the synchronizing circuit 13, the fast A/D converter 14, the data processing unit 15 such as a microprocessor, the memory 16 and the interface units 17, 18 for instance for the user and additional data processing and/or process control activities respectively.

Both measurements are carried out by aid of the same web sensor 11, or by aid of two separate web sensors, which are connected for instance to the same fastening clamp or the like. While measuring the darkness of the colour surface, the measurement is repeated on successive printing sheets or equivalent, and the measuring result proper is calculated as an average of the partial measurements. The optical intensity of the scattered radiation, which is used in the measurement of the darkness of the colour surface, is utilized while defining the accurate location of the edges of the test surfaces, on the basis whereof the reciprocal registrations of the different colours are calculated, whereafter they are available for the information of the user and/or feedable into the adjusting system of the printing process.



## PATENT CLAIMS

1. A method for controlling print quality in a web printing press by measuring at least the darkness of the colour surface by means of a web sensor, wherein on a moving paper web there is arranged a test spot and/or test patterns in the middle and/or aside the saleable printing, and the operation of the web sensor is synchronized with the said test spots while they pass the sensor along with the paper web, and wherein a light beam is focused from the light source of the web sensor onto the paper web, and the reflections of the said light beam from the test surface are measured by means of a light detector, characterized in that the spot of light formed on the paper web by the light beam is limited, in comparison with a conventionally used spot of light, at least in the moving direction of the paper web, for instance so that it is roughly between 1-2 mm.

2. The method of claim 1, characterized in that by aid of the limited spot of light of the same web sensor, also the reciprocal registration of different colours is measured.

3. The method of claim 2, characterized in that the same test spots and/or patterns are employed while measuring both the darkness of the colour surface and the registration of different colours.

4. The method of claim 2 or 3, characterized in that the obtained measuring results concerning the darkness of the colour surface and the registration of different colours are processed in separate data processing units.

5. The method of any of the preceding claims, characterized in that by employing the light source of the web sensor, several adjacent test surfaces are illuminated.

6. The method of any of the preceding claims, characterized in that a cylinder lens is used

in the web sensor.

7. The method of any of the preceding claims, characterized in that the measurement is repeated on successive printing sheets or equivalent, or within the same test area, and the measuring result proper is calculated as an average of the partial measurements.

1/2

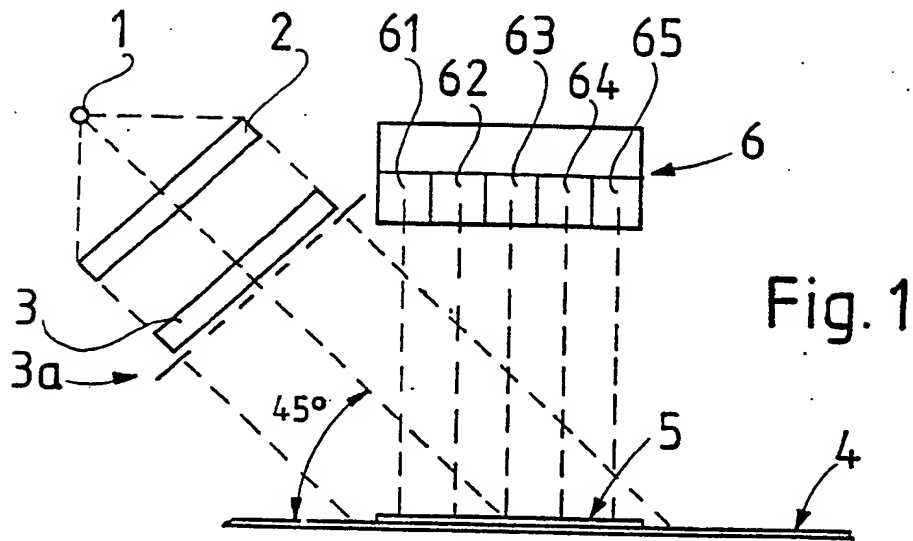


Fig. 1

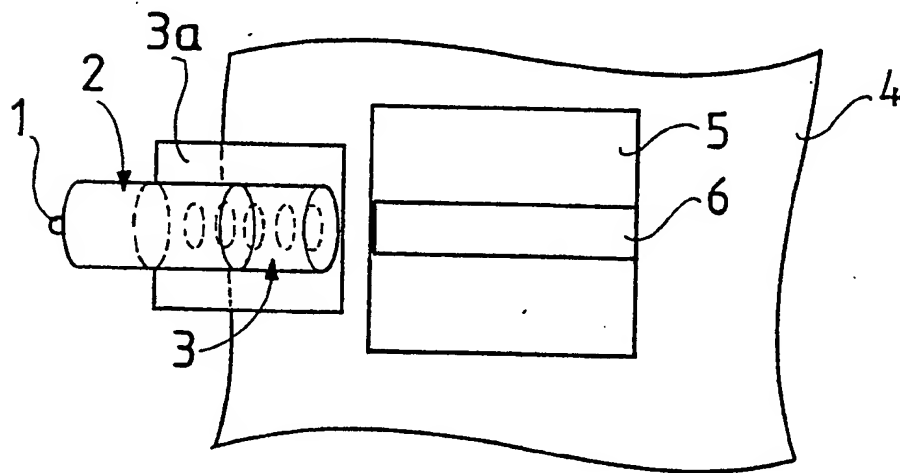


Fig. 2

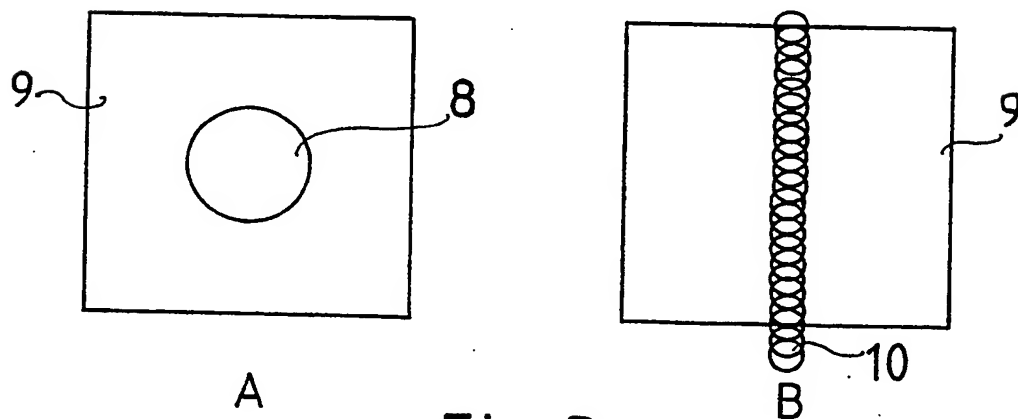


Fig. 3

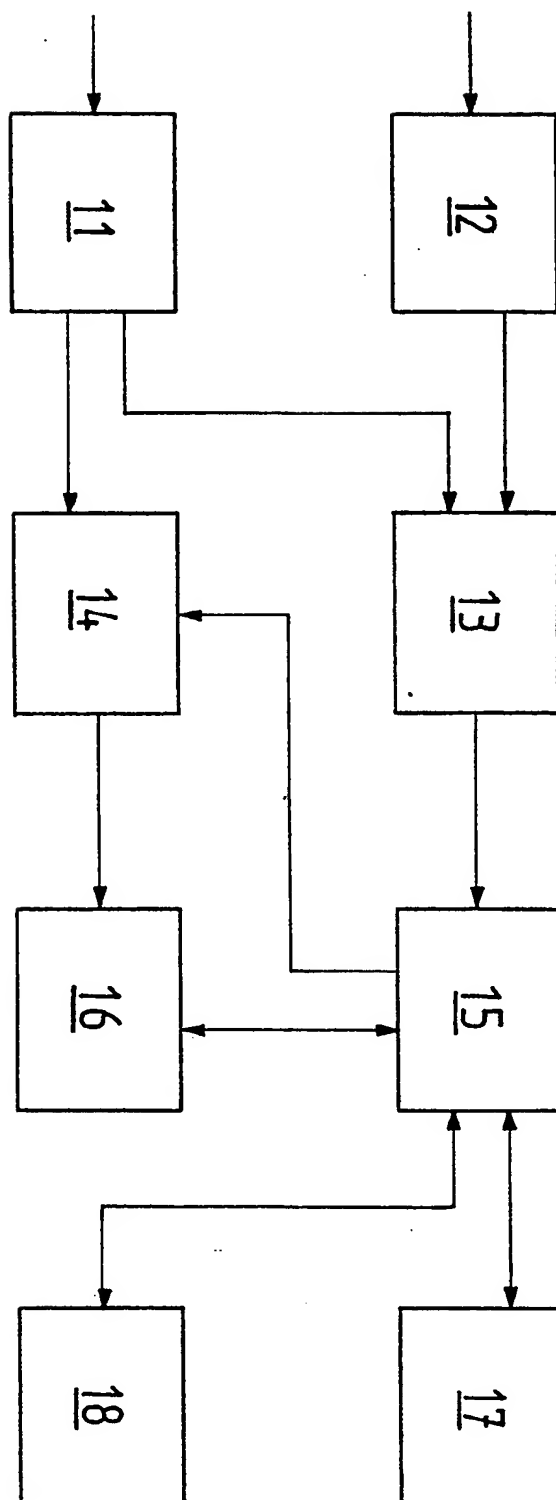
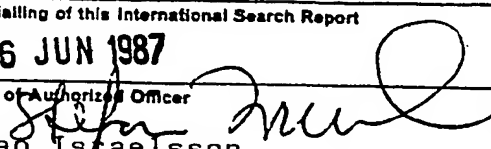


Fig.4

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/FI87/00049

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC B 41 F 33/00, G 01 J 3/50, G 01 N 21/86 4		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched 7		
Classification System	Classification Symbols	
IPC 4	B 41 F 33/00, /14; B 65 H 25/00, /10, 26/00; G 01 J 3/46, /50; G 01 N 21/30, /86, /89	
US C1	209:580-582; 250:559, 562, 571, 572; .../...	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
SE, NO, DK, FI classes as above		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> *		
Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
X Y	GB, A, 2 066 949 (DAI NIPPON INSATSU KABU-SHIKI KAISHA) 15 July 1981 & JP, 56028525 JP, 56098634 DE, 3100304 US, 4488808	1,2,3,4,6 5,7
Y	GB, A, 2 064 113 (LICENTIA PATENTVERWALTUNG'S GmbH) 10 June 1981 & DE, 2947791	5
Y	SE, B, 382 944 (GRETAG AG) 23 February 1976 & NL, 7214821 FR, 2158465 DE, 2253189 CH, 538680 GB, 1367825 US, 3890048 JP, 48073190 .../...	7
* Special categories of cited documents: 10 "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(a) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "Z" document member of the same patent family		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search 1987-06-29	Date of Mailing of this International Search Report <b>26 JUN 1987</b>	
International Searching Authority Swedish Patent Office	Signature of Authorized Officer  Stefan Isaacsson	

Form PCT/ISA/210 (second sheet) (January 1985)

## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

III. Fields Searched (cont).

US C1 356:173, 179, 186, 191, 193, 200,  
209, 212, 237, 402, 408, 416,  
421, 424, 430

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE <sup>1</sup>

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ..... because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ..... because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ..... because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING <sup>2</sup>

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

## Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	EP, A2, 136 542 (KOLLMORGEN TECHNOLOGIES CORPORATION) 10 April 1985	1-7
A	DE, A, 2 060 000 (RUDOLF HELL) 15 June 1972	1-7